QAS3-c10 Assessment

14 Jan 1999

1) Fast Ion Confinement
   M. Redi

2) Collisional Thermal Confinement
   H. Mynick
   Z. Lin

3) Stability
   L.P. Ku

4) Boostrap Current & Equil. Islands
   C. Kessel
   D. Monticello

5) Operating Range & Summary Discussion
   M. Zarnstorff

Prioritization of Physics Requirements
(From PAC-2 answers)

1. Ballooning, kink, vertical stability
   - for disruption free operation at $\beta \geq 4\%$
   - beta-limiting mechanisms

   $\Rightarrow$ need sufficient confinement, flux surface quality

2. Transport optimization (QA'ness)
   - demonstrate compatibility with high-β, viability
   - enable access to high-β

3. robustness of configuration, flexibility

4. bootstrap alignment

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5. beam-orbit loss, magnetic field value
   - willing to lower B to attack β-limit, even at expense of some higher beam-orbit loss

6. external transform fraction
   if need more confinement, will raise iota via more plasma current (e.g. ohmic)

7. collisionality
   can relax collisionality to get more confinement
   (but need some bootstrap to neo-stabilize islands)

$\Rightarrow$ <u>backup strategies to ensure ability to attack top-level goals</u>

General Status

- Have not had time to iterate to evaluate a common self-consistent operating point

- Generally evaluating operating points derived using the Spreadsheet model
  - ISS95 confinement scaling
  - Axisymmetric estimates for beam orbit losses
  - Often: axisymmetric χ_i to estimate T_i

Operating Point and Summary For C10

M. Zarnstorff
14 Jan 99

Modifications to Spreadsheet model

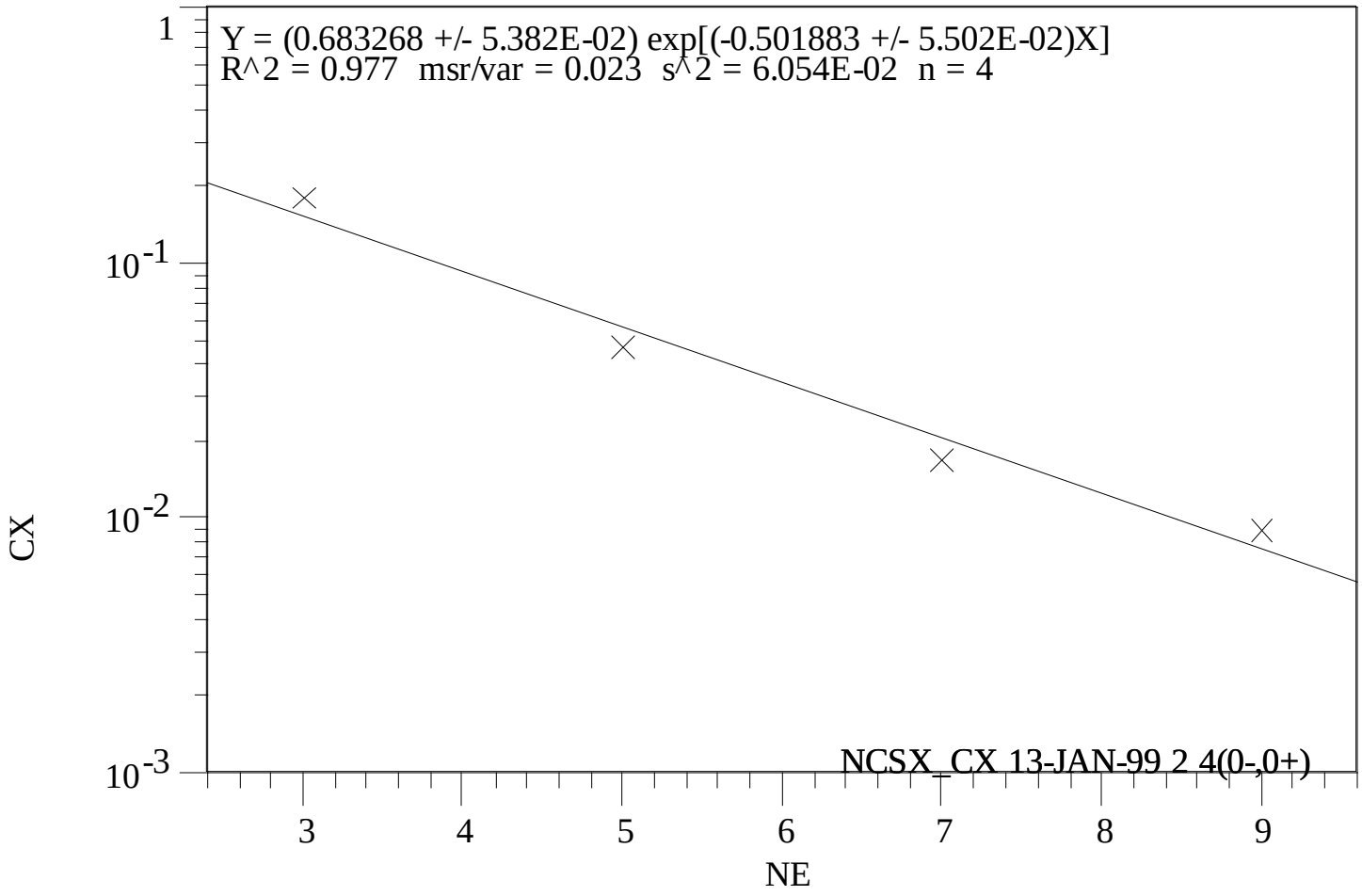
- add c10 fast-ion loss estimate
  - Appears to be no significant B dependence
  - take as lower bound of 49%,
    no collisionality dependence currently
  - for low-B: take max(49%, axisym. fit)

- Use Z. Lin's calculated τ_{Ei}^{neo}
  - use $\Phi/eT_i = 1$ result of 16.6ms for 1.26T
  - fit B dependence, gives $\tau_{Ei}^{neo} \propto B^{1.36}$
  - no T dependence currently
  - expect electron confinement to be similar to ions for stellarator (but not yet calculated)
    $\Rightarrow$ no $(W_e+W_i)/W_e$ enhancement

  - take estimated $\tau_E = \min(\ 2.3*ISS95,\ \tau_{Ei}^{neo}/2\ )$

- put in fit to CX losses as a function of $\langle n_e \rangle$ for C10 size and PBX-M beam geometry

  - no longer a constraint on required density
    just estimate the losses and include in confinement


Y = (0.683268 +/- 5.382E-02) exp[(-0.501883 +/- 5.502E-02)X]
R^2 = 0.977 msr/var = 0.023 s^2 = 6.054E-02 n = 4
NCSX_CX 13-JAN-99 2 4(0-,0+)
CX
NE
1
10-1
10-2
10-3
3
4
5
6
7
8
9

c10 Optimizations

	old opt (PAC)	new model	new, only 1*tau-neo	ignore stell tau-neo
B	1.23	0.76	0.75	0.7
P (MW)	6	6	6	6
n (10^19 m^-3)	5.5	8.43	6.8	3.62
estimated orbit loss	0.2	0.49	0.49	0.49
estimated CX loss	---	0.10	0.11	0.205
Absorbed P (MW)	4.8	2.8	2.7	2.4
2.3*ISS95	0.025	0.033	0.03	0.022
tau-neo-stell est.		0.0083	0.0082	0.0075
tauE assumed	0.025	0.004	0.008	0.022
beta	3.30%	0.65%	1.30%	3.49%
T(0) (keV)	2.2	0.11	0.27	1.19
nR/T^2	~2	1007	140	3.7

Further Work

- calculate electron thermal confinement
  also T dependence of transport,
  self-consistent E_r level

- calculate beam and thermal confinement for H instead of D

- c76 and i63

- understanding discrepancy with D.Spong's beam-ion code